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ABSTRACT

Observation statements are characterized as being: (1) dependent upon the human senses or other sensory apparatus; (2) specific descriptions; (3) made by speakers who offer as the primary support for their statements the events or things which stimulated their making the statements; (4) used as the foundations for knowledge; and (5) easily believed by experts in the field in question. Thirty criteria or principles for critically judging the reliability of such statements are presented. First, observation statements are more reliable than the inferences based upon them. Second, certain observer characteristics affect reliability: emotionality; alertness; conflict of interest; skill with thing observed; theoretical understanding; normal senses; reputation; precision; skill with observation technique; and bias. Third, characteristics of the observation condition affect reliability: the instrument precision; quality; condition; range of application; and ease of understanding. Finally, reliability of the observation statement depends upon characteristics of the statement itself: commitment of speaker; corroboration or documentation; precision; fit into body of knowledge; and basis upon record. The statement should be made and believed by the observer, close to the time of observation. These criteria provide theoretical support for a test or curriculum on judging the reliability of observation statements. (CP)

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THE DEPENDABILITY OF OBSERVATION STATEMENTS

BY

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THE DEPENDABILITY OF OBSERVATION STATEMENTS[1]

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Observation statements report the results of observations. Observations play prominent roles in many situations and in many occupations. The following suggest the diversity of situations and occupations in which observations play a major part. In order to be an accomplished detective, Sherlock Holmes devoted much effort to sharpening his powers of observation. In attempting to determine the guilt or innocence of defendants, courts place much weight on the observations of eye-witnesses.[2] In attempting to teach students some things about the scientific method, science teachers often begin by telling their students that dependable observation is part of the foundation of all scientific knowledge.[3]

Because of the importance of observation in situations such as those mentioned above and in many other types of situations, people are often called upon to decide whether to accept or to reject observation statements. In many of these situations, individuals make correct decisions by using their own experience as a guide. More systematic and general guidance than that received from one's own experience is, however, not readily available. Such general and systematic guidance would rely upon the accumulated experience of human beings in dealing with situations in

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which observation statements needed to be judged. If such guidance were available, it ought to be a useful aid in correctly assessing observation statements.

Guidance of this sort is available, but not readily so. Principles for judging observation statements based upon centuries of judicial practice, scientific practice, and experience in everyday affairs are followed in many fields. If these principles were systematized, they could, presumably, form the basis for some school curriculum. Then, when faced with important decisions about the acceptance or rejection of observation statements, the people taught would have some critieria to apply in making sound judgments.

The major purpose of this paper is to present a systematic set of general principles for assessing observation statements. For many of the principles I will illustrate their application by examining particular cases. I will illustrate exceptions to the principles and urge that the effect each principle is to have on judgments in particular situations must be decided by taking into account the idiosyncrasies of those situations. Application of the principles requires judgment and flexibility. I will stress these requirements throughout the paper.

OBSERVATION STATEMENTS

In this section I will give some critieria which can serve as useful aids in distinguishing observation statements from other kinds of statements.[4] I will begin by giving some examples of statements which I consider to be observation statements. I will then discuss the features of those statement which could be used to identify them in this way.[5]

In the following situations, as I am thinking of them, the people would be making observation statements. A child counts the number of lines in a poem and says to her teacher, "This poem has fourteeen lines." While driving your car you look at the fuel gauge and say, "The tank is half full." Some lights go out in your house. You check the fuse box and say, pointing to a particular fuse, "That fuse is blown." A physicist looks at an ammeter on her laboratory desk and says, "The current in the wire is five amps."

I say "as I am thinking of them" in the first sentence of the last paragraph because if someone were to make certain assumptions about the situations that I have not made, then that person might judge correctly, given those assumptions, that the statements are not observation statements. For example, in the blown-fuse situation, suppose that you, the person who stated the fuse is blown, had never before seen a blown fuse. Suppose, in addition, that the reasoning that preceded your statement went like this: "Most of the eight fuses in this box look very similar to each other. There is one fuse that does look different from the others though. The glass cover appears blackened by some substance. Also, there is no silver wire inside this fuse but there is one inside each of the others." In such a case, according to the manner in which I want to use the term 'observation statement', your statement that the fuse is blown would not be an observation statement but rather an inference based upon the statements that were made prior to it. These prior statements would be observation statements.

To illustrate how one might decide which of the above statements are observation statements I will discuss some of the characteristics of observation statements, as I conceive of them, which distinguish them from

other types of statements.[6] As I will show, to distinguish a statement as an observation statement requires taking into consideration each of the characteristics which I will discuss as well as the features of the situation in which the statement was made.

In the situations in which they are made, observation statements are characterized by:

A. being closely dependent upon the human senses or other sensory apparatus.

By "other sensory apparatus" I am referring to such devices as thermometers, tire pressure gauges, light meters on cameras, and sound intensity meters, which are often used to make observations that could not be made with the human senses alone. Such devices are often called "extensions to the senses", a description which suggests that their function in making observations is similar to that of the human senses.

Characteristic A is, I believe, an essential characteristic of observation statements. In the situations in which I have imagined the following statements being made, they would not be observation statements because they do not depend closely upon the senses: "One should not make promises one does not intend to keep"; "The square root of nine is three"; and "Water freezes at zero degrees celsius."

One might be able to imagine situations different from the ones I have imagined in which the above statements would be closely dependent upon the senses. For example, suppose a person did not know that by definition the freezing point of water is zero degrees celsius. Such a person might set out to determine the temperature at which water freezes by measuring the temperature with a thermometer. If a person cooled some water until it began to freeze, read the thermometer immersed in it, and concluded from the temperature, "Water freezes at zero degrees celsius",

then that statement would be closely dependent upon the senses of the speaker in this situation, and would thus possess the essential characteristic A of observation statements. Judging whether the statement is indeed an observation statement would require taking other characteristics, which I will discuss presently, into account. My intention in considering this hypothetical case is to emphasize what I have previously stated: judging correctly whether or not a statement is an observation statement usually requires one to take into consideration the features of the situation in which the statement was made.[7] In the example just discussed the speaker's background knowledge about the celsius temperature scale is a feature of the situation to take into account in judging whether the statement is an observation statement. I say "usually" in the underlined part of the sentence above because I cannot imagine any situation having features such that certain statements would be observation statements. Here is an example of such a statement: "One should not make promises one does not intend to keep." I cannot imagine any situation in which that statement would be an observation statement. The discussion which follows of characteristic B should make clear the reasons why I cannot imagine this. The statement does not have characteristic B. In fact, the other two statements, "The square root of nine is three" and "Water freezes at zero degrees celsius", also do not have characteristic B.

Some people might also be puzzled about what is actually being observed when some sensory device other than one of the human senses is used to make an observation.[8] For example, if a thermometer is used to measure the temperature of water, a person might claim that what is being observed when someone reads the thermometer is the height of the column

of liquid in the thermometer and not the temperature of the water. The critic might then conclude that the statement "The water is ten degrees celsius" would not be an observation statement in such a situation. Rather, it would be a conclusion based upon the observation statement "The column of liquid has risen as far as ten on the scale." Since some of the characteristics of observation statements which I have yet to treat will help me deal with this problem more effectively, I will defer discussing it until I have discussed those characteristics.

In the situations in which they are made, observation statements are characterized by:

B. being descriptions of some specific things that have happened or the states in which some specific things are.

The following statements have characteristic B in the situations in which they are made. You measure the air pressure in the tires of your car and say, "The air pressure in the right rear tire is twenty-five pounds per square inch." A student is conducting a chemistry experiment and is watching what happens as he or she adds one liquid to another. The student says, "The colour of the mixture just turned pink." A mechanic has examined your car and says to you, "The flexible hose leading to one of your car's brakes has deep cracks in it." A psychologist gives a person an IQ test, scores the test and says, "The person received a score of 96 on the test."

Characteristic B limits the form that observation statements can take. Statements which are not descriptions of some specific state of affairs in the world are disqualified from being observation statements. For example, I cannot imagine a situation in which the statement "All matter is composed of atoms" would be used to describe some specific thing. Rather, it describes some things in general, all pieces of matter. Thus, it

is not an observation statement. As another example, the statement "Killing is wrong" would not be an observation statement in any situaton in which I can imagine it being made. I cannot conceive its being used to describe something.

A statement's having characteristic B, or any other of the characteristics of observation statements that I discuss in this paper, does not guarantee that the statement is an observation statement. The following example illustrates this fact. In the example I give a statement that has characteristic B and show that it is not necessarily an observation statement. Suppose I make the following statement: "The Library of Congress has a copy of The Encyclopaedia Britannica." If I made that statement at the time I am writing this paper, it might be a true statement. I suspect that it is. If it is true, it describes the way some specific thing is; it says that a specific library has a copy of a particular publication. It is not an observation statement, however. I have never been to the Library of Congress up to the time of writing this paper and have had no other means of observing the books on that library's shelves. In addition, no one has told me that he or she has seen a copy of the Britannica on the shelves of the Library of Congress. So, I would not even be giving a secondhand observation statement by reporting an observation that someone else has made. What I would be doing is inferring from what I know about the holdings of the Library of Congress that the library would have a copy of such a famous publication as the Britannica. In short, my statement would not have characteristic A.

One cannot decide with confidence on the basis of a statement's having any one of the characteristics that I discuss that the statement is an observation statement. The example just discussed illustrates the soundness of this caution.

In the situations in which they are made, observation statements are characterized by:

C. being made by speakers who offer as the primary support for the statements the events or things which stimulated their making the statements in the first place.

This characteristic illustrates that observation statements are basic to our knowledge of the world. When people make observation statements they usually do not go through prior lines of reasoning upon which the statements are based. For example, the driver of a car usually does not go through a line of reasoning leading up to the statement, "There are several gallons of gas in the tank." She merely looks at the fuel gauge and utters the statement based upon what she observes. If asked by a passenger how she knows that there are several gallons of gas in the tank, the most appropriate response the driver can make in most circumstances is to point to the fuel gauge, that is, to ask the passenger to make the observation himself. If the passenger is not then convinced that there are several gallons of gas in the tank but persists in his questioning, it is likely in usual circumstances that the driver will not know how to respond further. The strongest support she has for her statement that the tank is half full is the position of the fuel gauge, the thing which stimulated her to say that there are several gallons of gas in the tank. If the passenger is not satisfied with this support, the driver might see no other approach that could work.

The discussion of the previous example assumes that the driver and passenger know the meaning of various positions of the fuel gauge needle. For most people in our society these are reasonable assumptions, I believe. That is why I said, "in most circumstances" and "in usual circumstances" in the last paragraph. If the passenger persists in his questioning after

he has been shown the fuel gauge, the driver might become puzzled because he assumes the passenger knows what the gauge reading means. Faced with this puzzle the driver might think either that the passenger does not know the meaning of the fuel gauge reading or that the passenger is trying to be contentious. If he thinks the first of these, that the passenger does not know the meaning of the fuel gauge reading, the driver might try to explain to the passenger how the gauge works and what various readings mean. The statement "There are several gallons of gas in the tank" would for such a passenger be one that needs to be supported by other statements which show how the gauge reading is linked to the amount of fuel in the tank. For this passenger the statement would not be an observation statement. For this passenger the primary means of supporting the statement is not only to point to the fuel gauge but also to give a line of reasoning which connects the gauge reading to the amount of fuel in the tank. Hence, for this passenger the statement is not characterized by characteristic C.

The above example shows that the knowledge of the speaker who makes a statement is one of the factors that determines whether that statement is an observation statement. For physicists the statement "The current in the wire is five amps" is usually an observation statement. Physicists' training makes them thoroughly familiar with the electrical terms 'current' and 'amps' and with the application of these terms. Because of this familiarity, among physicists the primary support usually given for the above statement is the reading on the dial of an ammeter, that is, the phenomenon which stimulates the making of the statement. However, among people not knowledgeable in the terms used to describe electrical phenomena statements about the amount of current flowing in wires are not

observation statements. For those people the primary support for such statements is not the phenomena which would stimulate a physicist to make the statements. For people not knowledgeable in the field such phenomena would not be recognized as support. For them support would have to include a list of statements which give the meaning of the technical terms used and which show how the phenomena observed is connected to the statement made.

As a rule of thumb, to get an idea whether or not a statement has characteristic C ask the person who made the statement the following question: "How do you know?" For example, to see whether the statement "The fuse is blown" has characteristic C ask the speaker how he or she knows that the fuse is blown. If in answer to your question the speaker shows you the blown fuse or says that he or she personally saw that the fuse is blown, then it is likely the statement has characteristic C. If the speaker says something like: "Well the lights in the living room would not work. A note on the fuse box says which fuse controls the living room. Therefore...", then the statement "The fuse is blown" probably does not have characteristic C.

In the situations in which they are made observation statements are characterized by:

D. being used as the foundations for knowledge in those fields in which they are observation statements.[9]

This characteristic is closely related to characteristic C. Characteristic C says that observation statements do not receive their prime support in the context in which they are made by appeal to other statements. Rather, they receive their prime support by appeal to the phenomena they describe. Characteristic D says that observation statements are offered as the basic support in particular fields for statements other than observation

statements which constitute the knowledge in those fields. They are able to be offered as basic support because they have characteristic C.

Consider the following example. Statements about the tendencies of certain types of people to behave in certain ways make up a large part of the knowledge of psychology. A psychologist might offer a piece of this knowledge by stating the following "IQ scores correlate highly with school achievement scores." The psychologist's statement is not an observation statement because it lacks some of the charactersitics of observation statements, in particular characterisitics B and C. However, it is based on observation statements. Observation statements like the following might be used to support it: "John Doe got 120 on the Wechsler IQ test and had a 4.0 GPA" and "Jane Doe got 135 on the Wechsler IQ test and had a 4.75 GPA." If asked to support these latter statements, the psychologist would likely appeal to the phenomena that the statements describe. The psychologist might produce John's and Jane's answer sheets, for example. It is unlikely that the psychologist would appeal to other statements in support. The psycholgist's means of supporting the statements about John and Jane Doe illustrates that these statements have characteristic C. The whole example illustrates that the statements about John and Jane, having characteristic C, can be used so that they have characteristic D.

The point is that the psychologist does not consider anything more basic to the support of his or her generalization about IQ and achievement than his or her observations. A critic of this view might suggest that the psychologist might use some theoretical considerations to support his or her generalization. For example, the psychologist might say the generalization reached is that which one might expect based upon certain theories of human nature. But then these theories themselves would have observation statements as part of their foundational support.

You can always ask the question "How do you know?" to a scientist who has made some statement. Often that scientist will be able to support his or her statement with some other statement upon which the first statement depends for its support. However, if you then ask the scientist to support the statement he or she has offered in support and continue to do this for every statement given in support of other statements, you will eventually reach statements for which the scientist will merely point to some phenomena for their support. These statements which are not supported by other statements are observation statements and serve as part of the foundations or basic support for the other statements in the field in question.

In the situations in which they are made observation statements are characterized by:

E. the fact that people knowledgeable in the field in question who have made the same observation will quickly agree that the statement is true.[10]

The qualification that the people making the observation be knowledgeable in the field in question is an important one. Consider the following case where the two individuals doing the observing are not both knowledgeable in the area of concern. Suppose that one of the individuals is an economist. Suppose the other is not an economist and knows very little economic theory and very little of the language economists use to report their observations. Both individuals are examining the same piece of paper which reports on the day's economic business. The economist reports her observations in the following statement: "All major economic indicators showed a decline today." The person who is not an economist cannot agree or disagree with the statement because, having no economic training, he does not even know what the statement means. However, had another economist been present and had that other economist observed the

same thing as the first economist, then that other economist would have quickly agreed with the report of the first economist .

Similar situations to the economic one described above occur among people who have no specialized training at all. Consider the case of a parent speaking to his child who has not yet mastered the use of much of the language. Suppose the child uses a few nouns to identify things but has not yet learned to identify colours. The parent says to the child, while pointing to an apple which they both can see, "The apple is red." The fact that the child is not able to agree or disagree with the statement her parent has made does not, in this situation, count against the statement being an observation statement for the parent. The child, not having mastered the use of the word 'red', cannot be expected to agree or disagree with the statement. However, most people who have mastered the use of the language could assent quickly to the parent's statement, if the statement was correct, that is. Thus the statement would usually have characteristic E.

At this point I am able to more completely discuss the example which was left dangling in the section treating characteristic A. In the example in question, I raised the problem of whether the statement "The water is ten degrees celsius" is an observation statement or whether it is an inference based upon the observation statement "The column of liquid in the thermometer has risen to the line marked 10°." The problem can be treated by considering characteristics C, D and E of observation statements. These characteristics focus one's attention respectively on that which the speaker considers support for the statement, on the function of the statement in the field of knowledge to which it belongs, and on how other speakers might view the statement. The statement "The water is ten

degrees celsius" when made in many, if not most, contexts among accomplished speakers of the English language possesses each of these three characteristics.

If a critic insisted that the statement about the water temperature really is an inference based upon the statement about the position of the liquid in the thermometer, you might agree that it might be an inference. The critic might say that in his or her sense of the word 'observe' a person could not be said to observe water temperature but only the height of a column of liquid. If this is the sense of the word intended by the critic one might ask him or her whether one can really observe a column of liquid or merely a column of somthing red inside a glass tub. Or one might ask the critic whether one can really observe something red inside the tube or merely some red light which appears to be emitted from something inside the tube. Maybe the critic would want to limit even more severely the things we really observe. But, I believe, one might ask the critic what the point is in limiting in this manner the objects we can be said to observe. In my dealings with thermometers that I can recall, the people with whom I have dealt have not been interested in the appearance of red light being emitted from something inside a glass tube or in the height of a red column of liquid. These people at least have not spoken of red columns of liquid or of the appearance of red light. They have spoken of the temperature of the substance the thermometer was indicating. I believe there is a point to using 'observe' in a way which allows one to say that people observe the temperature of something in reading thermometers. Part of the point is that I wish my analysis to directly apply to the way people usually speak. The statements people usually make when reading thermometers are statements about the temperature of

something not about the height of a column of liquid. In addition, statements about temperature read from thermometers usually have special status in our language compared to statements about the height of the liquid column in thermometers. Statements about temperature, and not statements about the height of columns of liquid, are the statements which are usually used to decide upon courses of action. For example, if one wants to go swimming or make yogurt one uses information on the temperature of the water not on the height of a column of liquid to govern one's actions.

However, one can imagine situations in which a statement about the height of the column of liquid in a thermometer might be a more appropriately called an observation statement than a statement about temperature. The following are examples of such situations. A person is checking the accuracy of a newly constructed thermometer using a thermometer having a certain accepted accuracy. In such a case, the person might reasonably focus on the heights to which the liquid rises in each thermometer and make observation statements about the heights observed. For the courses of action the person will make based on his observations, speaking of the height of the liquid columns is a perfectly appropriate way of speaking.

There may also be special reasons for a person's reporting his observation in terms of the height of the liquid column rather than in terms of temperature. Saying that the liquid has reached a certain height commits the speaker to holding fewer things to be so than saying that the temperature of the substance is such-and-such. In a situation of reading a thermometer, saying the temperature of a substance is such-and-such commits one to holding two things true: (i) the temperature of the substance is such-and-such and (ii) the height of the liquid in the thermometer corresponds to that temperature. Saying that the liquid in the

thermometer has reached a certain height does not commit one to holding (i) above. One can be fairly certain that the thermometer is inaccurate to some degree. Hence, the thermometer reading will not correspond precisely to the temperature of the substance being measured. In a situation in which knowing the temperature to a more accurate degree than is possible using the thermometer available is desirable, one might speak of the height of the liquid column to avoid deciding on courses of action based on inadequate information. In such a situation, it might be useful to think of statements about temperature to be dependent upon statements about the height of the liquid columns. In such a situation the statements about temperature would not have characteristics C and D and thus would not be observation statements.

Statements that have the five characteristics I have described have a special status in our language. Such statements are among the most reliable statements that we make about the world. They tend to provide reliable guides to action. Also, because observation statements so picked out serve as the basis for much of our other knowledge, the reliability of this other knowledge tends to be limited by the reliability of these statements. A statement, in most cases,[11] cannot be more reliable than the statements upon which it is based. Because of the limiting effect the reliability of observation statements has on the reliability of other statements upon which we depend, concentrating on increasing the reliability of observation statements, and also concentrating on the nature of observation statements, is an important and useful thing to do.

In summary, the distinction I wish to draw between observation statements and other kinds of statements can be made only by attending to many of the features of the situations in which the statements are made.

The dependence of the statements upon the senses, the descriptiveness of the statements, the speakers' background knowledge, the function of the statements as the basis of other statements, and the degree to which the statements draw quick assent are features which must be considered. Distinguishing in this way certain statements as observation statements is useful because doing so in particular situations often points to the statements in those situations which are the most reliable. This last characteristic of observation statements, their reliability, will be the focus of a large part of the remainder of this paper.

The following characteristics of observation statements which I have discussed in this section are useful in distinguishing them from other types of statements. In the situations in which they are made, observation statements are characterized:

A. by being closely dependent upon the human senses or other sensory apparatus;

B. by being descriptions of some specific things that have happened or the states in which some specific things are;

C. by being made by speakers who offer as the primary support for the statements the events or things which stimulated their making the statements in the first place;

D. by being used as the foundations for knowledge in those fields in which they are observation statements;

and E. by the fact that people knowledgeable in the field in question who have made the same observations will quickly agree that the statements are true.

PRINCIPLES FOR JUDGING THE RELIABILITY OF OBSERVATION STATEMENTS

The list of principles which I present here is based upon a list presented by Robert Ennis.[12] Both Ennis and I intend the principles to be guides in judging the reliability of observation statements. They can be thought of as factors to consider in making a judgment of reliability.

The principles concern two main topics: (i) the comparative reliability of observation statements and inferences based upon them, and (ii) factors affecting the reliability of observation statements. The principles dealing with the factors affecting the reliability of observation statements concern three main areas: the observer, the observation conditions, and the observation statement.

Here are the principles:

Topic I. The comparative reliability of observation statements and inferences based upon them

I.1 Observation statements tend to be more reliable than inferences based upon them.

Topic II. Factors affecting the reliability of observation statements

Area II.1 An observation statement tends to be reliable to the extent that the observer:

II.1.1 does not allow his or her emotions to interfere with his or her making sound judgments;

II.1.2 is alert to the situation and gives his or her statement careful consideration;

II.1.3 has no conflict of interest;

II.1.4 is skilled at observing the sort of thing observed;

II.1.5 has a theoretical understanding of the thing observed;

II.1.6 has senses that function normally;

II.1.7 has a reputation for being honest and correct;

II.1.8 uses as precise a technique as is appropriate;

II.1.9 is skilled in the technique being used;

and II.1.10 has no preconceived notions about the way the observation will turn out;

Area II.2 and to the extent that the observation conditions:

II.2.1 provide a satisfactory medium of observation;

and II.2.2 give the observer good access to the thing observed.

(If in gaining access some instrument is used, then the statement tends to be reliable to the extent that the instrument:

II.2.2a has suitable precision;

II.2.2b has a suitable range of application;

II.2.2c is of good quality;

II.2.2d works in a way that is well understood;

and II.2.2e is in good working condition.)

Area II.3 and to the extent that the observation statement:

II.3.1 commits the speaker to holding a small number of things to be true;

II.3.2 is corroborated;

II.3.3 is no more precise than can be justified by the observation technique being used;

II.3.4 is made close to the time of the observation;

II.3.5 is made by the person who made the observation;

II.3.6 is strongly believed to be corroboratable by the person making it;

II.3.7 does not conflict with other statements for which good reasons can be given;

and II.3.8 is based upon a reliable record, if it is based on a record.

(If it is based upon a record, then the statement tends to be reliable to the extent that the record:

II.3.8a was made close to the time of the observation;

II.3.8b was made by the person who made the observation;

II.3.8c comes from a source having a good reputation for making correct records;

and II.3.8d is believed by the person making the statement to be correct.)

Two aspects of the wording of the principles needs to be explained. I used "tends to be reliable" and "tend to be more reliable" because although the principles are very general they do have exceptions. For example, although observation statements tend to be more reliable than inferences based upon them, they are not always more reliable. The following is an example in which the inference is more reliable than the observation statement upon which it is based. Suppose that after the ballots had been counted in the election of the mayor for a certain small town having 250 eligible voters the number of votes received by each candidate was reported in the following observation statements by the person who had counted them: "Candidate A received 176 votes" and "Candidate B received 62 votes." Based upon these statements the following is inferred: "Candidate A received the majority of the votes cast." I believe that the inference in this case is more reliable than either of the observation statements upon which it is based. I am led to this belief by my knowledge of the running of elections. It is not uncommon in elections for the counting of ballots to be slightly inaccurate. This is the reason for candidates' asking for recounts when the reported results are close.

While 'close' is a loose word in that it does not refer to any particular number, experience in the counting of ballots gives some guides in applying the word in particular situations. In the situation I have imagined the results differ by about 50% of the votes cast. This would not be considered a close election. It would be extremely unusual for a ballot count to be mistaken by such a large percentage. The inference that Candidate A received the majority of the votes would not likely change if there was a recount. However, the actual vote counts might change by a small amount. Thus the inference is less likely to require change on the basis of a recount than the reports upon which it is based. Therefore, the inference is more reliable than those reports.

Another aspect of the wording of the principles that needs to be explained is my use of the conjunction 'and'. Under the topic "Factors affecting the reliability of observation statements" the principles within each of the three areas are conjoined using 'and'. Also the three areas are conjoined using 'and'. The reason for doing this is that individual principles or areas of principles cannot be considered by themselves as the basis for making a decision about a statement's reliability as if the list of principles is intended to suggest a set of necessary or sufficient conditions that must be met for a statement to be reliable. Instead, for each decision, the entire combination of factors suggested by the principles and one's knowledge of the situation and experience in similar stiuations must be considered and weighed. For example, a reliable observation statement can be made even though the observer did not use precise techniques. Thus, using precise techniques is not necessary for a statement to be reliable. On the other hand an observation statement can be unreliable even though the observer used precise techniques. Thus, using precise

techniques is not sufficient, by itself, to make a statement reliable. Also, one's knowledge of the situation and similar situations, such as one's knowledge of how to interpret the word 'close' in the election example, must be used in addition to one's knowledge of the principles.

The following example illustrates that deciding upon the reliability of a statement based upon one principle can lead to mistakes. It also illustrates that experience in the type of situation being considered is required.

> A novice technician measures the length of a brass cylinder using an expensive, precision caliper. The instrument is designed to give accurate readings over a wide range of temperatures. The present temperature is well within these limits. The novice has just been instructed in the use of the instrument and has not yet mastered the technique. He states his reading, "The cylinder measures 6.023cm." His instructor uses a steel ruler to check the instrument. The ruler is not designed to be as accurate as the caliper. She says, "The cylinder's length is between 6.03cm and 6.04cm."

In this situation the novice's using a precise technique to make his observation counts in favor of the reliability of his statement. His being a novice, and thus a person lacking in experience, counts against the reliability of his statement. Counting in favor of the reliability of the instructor's statement is the fact that she is experienced in making the sort of observation involved. Counting against the reliability of her statement is the fact that her technique was not as precise as the one used by the novice.

The situation is typical of most situations in which judgments of reliability need to be made. It is one in which different principles suggest conflicting judgments. If one followed the principle concerning the effect using precise techniques has on the reliability of observation statements one would come to a different conclusion than following the principle concerning the effect of experience on reliability. But both principles must be taken into account.

In this situation, as in any other situation in which the list of principles will be used, there is no way to give precise numerical weights to different principles. Sound judgment based upon much experience using the principles and familiarity with the type of situation must be used to determine the priority of competing principles. In the example under consideration I believe the instructor's statement is more reliable for the following reasons. The instructor's greater experience takes precedence over the novice's using a more precise technique because of the vast difference in experience, the small difference in precision, and the fact that experience is, I believe, a more crucial requirement for making accurate measurements. If the situation was changed slightly so that the novice had some experience using the caliper and had become proficient in its use, then experience would probably be a less important factor than the difference in precision in making a reliability judgment. However, much would depend on how good the novice had become.

Notice that in making my judgment I had to rely on more than the principles themselves. Considering just the principles was not sufficient for making a judgment. Other things, such as knowledge of the comparative importance of experience and the use of precise techniques, had to be considered. The lesson to be learned from this example is that the principles can be useful only when used with informed judgment based upon knowledge of the situation at hand and experience in similar situations.

In the section which follows I will attempt to clarify the meaning of each of the principles by showing how each may be used in particular cases. The section will also emphasize what was said in the last paragraph, that is, that the principles must be applied by using informed judgment.

EXPLANATION OF THE PRINCIPLES AND ILLUSTRATION OF THEIR APPLICATION

Observation and Inferences

The first principle states that observation statements tend to be more reliable than inferences based upon them. The reason for saying this is that inferences can go wrong in more places than the observations upon which they are based. Consider the following example. A person attends a display of archaeological findings from the ruins of Pompeii. One of the objects displayed is a glass bottle. The bottle is quite symmetrical, has a very round opening at the top, and is coloured as evenly throughout as bottles made today. Suppose based upon this final observation that person infers that the inhabitants of Pompeii could colour their glassworks as well as bottles are coloured today. This inference is less reliable than the observation statement that the particular bottle on display is coloured as evenly as bottles made today. This is so because the inference depends upon many other statements being true in addition to the observation statement. For example, it must be true that the people of Pompeii were the ones who made the bottle on display. This could be false; someone visiting Pompeii from Greece many years ago may have brought the bottle to Pompeii. It must also be true that those who made the bottle were the ones who coloured it. This may be false. Maybe some chemicals, which were in contact with the bottle during the centuries it was buried, coloured it. This example shows that the inference can go wrong for all the reasons that the observation statement upon which it is based can go wrong, but it can go wrong for other reasons also. Hence, there is more of a chance that the observation statement is correct.

This first principle is based upon the assumption that there is an important distinction between the starting place and ending place in a line of reasoning. There is, I believe, a difference in the degree of immediacy of our knowledge between the statement that there is a green evenly-coloured bottle in front of us and the statement based upon this that the people of Pompeii were as skilled at colouring glassware as we are today. The distinction between observation and inference which I use in stating the first principle is intended to capture this difference. The importance in capturing it is that the beginning points in our lines of reasoning tend to be more reliable than the points we reach through the reasoning and it is often helpful to know at which places our lines of reasoning are most reliable. Recall, however, that the election ballot example of the previous section illustrated a case in which the beginning points in a line of reasoning are less reliable than the conclusion of this reasoning.

Factors Affecting the Reliability of Observation Statements

Consider the following case in which two opposing observation statements are made. It is a case which is not hard to imagine actually happening. It is also a type of case for which the decision of which observation statement to accept could have important consequences for you. The problem is to decide which of the statements is more reliable. You read the following report in your morning newspaper.

January 7, 1979

> Mr. Alan Wright of Stoneville reports having discovered a major defect in his new 1979 Venus. The Venus is a new model of car produced by Superior Motor Company for the first time this year. Mr. Wright says the incident happened while he was driving to work on the morning of January 5. On his way he must go down over Murray's Hill, which descends at a sharp incline for about two miles before reaching the downtown area. About half way down the hill, Mr. Wright reports, the brakes of his car started to fade. He says that he had to start pushing harder and harder on the brake pedal to get the same stopping effect. He said, "By the time I reached the

bottom of the hill, pushing with all the force of my two feet barely brought the car to a stop." Mr. Wright claims that in his thirty-five years driving he has never experienced such an incident. He says he has reported the incident to the auto manufacturer and to the consumers' group in the town.

We then interviewed a representative of Superior Motor Company who had the following to say. "Our quality control technicians tested the braking efficiency of twenty Venuses randomly selected from our December production. Each of the cars was brought to ten successive panic stops from sixty miles per hour. On the tenth stop none of the cars required more than fifty pounds of force on the pedal to stop the car at a rate of 0.9g. This is a very reasonable force to expect a driver to apply and is comparable to the force required in the best cars on the market today."

The observation statements I want to consider are the statements I have underlined. These statements are not in direct conflict with each other because both could be true. However, one provides evidence for and the other against a claim that the brakes on Venuses are safe. In this sense the statements do oppose each other. You can also see that if you were considering buying a Venus, believing one of the statements might lead you to make a different decision than believing the other.

I will now demonstrate how the statements could be evaluated according to the principles.

Area II.1: Characteristics of the observer

The first set of principles deal with the observer. Observers' characteristics are extremely influential factors affecting the reliability of observation statements.

Emotionality. The observer's degree of emotionality is a consideration because we know that many times our judgment is affected by our emotional state. For example, an avid football fan may mistakenly claim that a foul was committed against the home team because of his or her emotional involvement in the game and his or her strong desire for the home team to win.

In the current example Mr. Wright was probably very emotional. Most people would become quite fearful in such a situation. We have been given no evidence to the contrary so we can reasonably assume that he was emotional in this situation. This of course assumes that Mr. Wright at least believes he is telling the truth. It is possible that Mr. Wright's brakes did not fade at all even though he believed they did. In such a case he would probably experience the same emotions as he would if they really did fade. His observation statement would be false in this case and the puzzle would be to discover what caused him to have the misleading perception.

The fear emotion, if that is what Wright experienced, would probably be coupled after the incident with a feeling of anger while he was reporting his observation. He might be extremely angry at the automobile company for producing a car he considered unsafe. Both of these emotions could have influenced Wright's report. In his fear, the severity of the brake failure could have seemed much worse to Wright. In addition, his anger after the incident could have caused him to exaggerate the severity of the fade.

We have been given no evidence to believe either that the company's spokeswoman was emotional when making her statement or that the technicians were emotional at the time they made the brake tests. The actual tests were probably conducted before the cars were released to the public. So the technicians were probably not hampered emotionally due to pressure from Wright and the consumer group he contacted. The spokeswoman, however, was probably feeling some emotional presure when giving the report but likely not as extreme as the emotions felt by Wright. Hence, the spokeswoman's statement was probably influenced less by emotional factors than Wright's statement.

Alertness. From the information we are given we have no reason to suspect that degree of alertness was a factor here. We have no reason to believe that either Wright or the spokeswoman or the technicians were not paying attention to what they were doing.

Conflict of interest. A person has a conflict of interest when it is to that person's advantage that others believe that those things he or she says are true. It could be to the person's advantage if he or she stands to profit from the statement made. The profit could be a monetary one or something like the further advancement of a controversial point of view. I intend the notion being to one's advantage to be taken quite broadly.

We do not know whether Wright stands to profit from others' accepting his statement. We are not given enough information. However, if we knew that Wright was a member of the consumer organization with which he intended to register a complaint, this would be pertinent information in making our judgment. Such groups thrive on their ability to uncover safety-related defects in products. However, in this situation we should give Wright the benefit of the doubt and not assume that he is a member. Yet we should remain open to further evidence in this regard. Depending upon the importance of our making a correct judgment of the two statements, we might actively seek evidence about Wright's degree of conflict of interest, or we might deem that course of action too much trouble.

The automobile company spokeswoman is definitely in a position of conflicting interests. It is to the advantage of the auto company that Wright's statement be wrong and that the statement of the spokeswoman be right. Experience tells us that when the truth hurts there is a strong tendency to lie, or to at least to distort the facts. We do not know

whether the company spokeswoman has lied. All we know is that her statement is suspect. In such cases it is often wise to seek evidence on the statement from a source that does not have conflicting interests.

Skill with thing observed. We are not told whether Wright is skilled at observing the fading of brakes. However, we are told that he has been driving for thirty-five years. It is reasonable to assume that if a driver with Wright's experience says that his car behaved unusually, then that car probably did behave unusually. This gives us reason to take Wright's word that he did have to exert an inordiante amount of force on the brake pedal to get his car to stop.

We are given no information about the Superior Motor Company's technicians' skill at observing the behaviour of auto brakes. It seems reasonable, though, to assume that they had sufficient skill to make the observation reported by the spokesman. The observations which were reported seem to be the type which automobile company technicians would make many times and the type that they would be skilled at making.

Theoretical understanding. The theoretical understanding people have of the field in which they are making statements can affect the reliability of those statements. In the present case, whether the parties involved have a theoretical understanding of the way automobile brakes operate could affect the reliability of their statements. The following discussion illustrates how Wright's theoretical understanding could affect the reliability of his observation statements.

Wright reports in his observation statement that pushing with all the force of his two feet barely brought his car to a stop. What could have caused him to make this statement? One thing that could have caused him to make this statement is the event that the statement reports, if that

event really did occur. However, other things could have caused him to make the statement. For example, if in fact the brakes did not fade but instead the power brake system stopped functioning, then the car would not have behaved as Wright had reported. He would not have had to push as hard as he was able in order to barely bring the car to a stop. However, if Wright had no theoretical understanding of the way brakes operate, he probably would not have been able to distinguish the brakes fading from their losing their power assist. His lack of knowledge could then have caused him to interpret the change in the feel of the brakes as being a serious problem, such as the brakes' fading, when it really was not. Thinking something serious had occurred he probably would become very anxious. This anxiety could then adversely affect his judgment of the amount of force needed to stop the car and of the quickness with which the car came to a stop. If his judgment was adversely affected, his observation statement was probably also adversely affected.

Your decision about the reliability of Wright's statement should, then, be affected by what you know of his theroretical understanding of the matter. If you know that Wright knew little about automobile brakes, then this would reduce the reliability of what he said. To a person who did not know what was happening, a failed power boost system could be easily exaggerated to almost a complete brake failure. If you do not know anything about the degree of his understanding, then whether you should try to find out about it depends upon how important it is that you make a correct decision on the reliability of Wright's statement. However, without any more information about Wright, you should probably suspect that he has practically no understanding of the functioning of brakes. This suspicion might be based upon the fact that most people lack this understanding.

Regarding the company's spokeswoman different assumptions must be made. In the first place, the spokeswoman is reporting on what some other people have observed. The theoretical understanding of the technicians who made the tests on the brakes is what should be considered in this case. Unless you have reason to think otherwise, it is safe to assume that these technicians have a deeper understanding than Wright of the brakes on a car. Such understanding could affect the reliability of their observation reports in many ways. Consider the following situation. A test is performed on the brakes of a car and it is found that they perform poorly. There is a great deal of fade. However, theory would lead one knowledgeable in the field to suspect that the brakes should operate well, because of the following considerations: the material used for the friction surface has theoretical properties which would lead such a person to think that it was highly resistent to fade; the brakes were specially designed to dissipate large amounts of heat, and keeping brakes cool is a known way of reducing fade; and the brakes should have been adequate for a car twice as heavy as the one on which they were tested. These things might lead trained technicians to suspect the measurements they have made, that is, their observations. Suppose, on the basis of such a suspicion, they check the instruments and discover that the instrument for measuring the pedal force was defective. In such a case, their theoretical understanding of the situation would have prevented them from making an observation statement that was incorrect. If you assume, then, that the technicians have a high degree of theoretical understanding of the phenomenon they are examining, you should rate their statement more reliable because of this.

Normal senses. For Wright to have made a reliable observation it was necessary that his sense of touch was operating correctly. We are given no reason to believe otherwise. In addition, the sense of touch does not seem as susceptible to malfunction as some of the other senses. Eyesight and hearing seem to cause problems in a larger proportion of the population. It would probably be safe to assume that Wright's sensory equipment was in good working order.

The observation reported by the auto spokeswoman required the technicians to use sensing apparatus in addition to their own senses. Such apparatus as thermometers, acceleration meters, and pressure gauges were probably needed. The various instruments for measuring deceleration rate, applied pedal pressure, and temperature of the brakes can all be considered part of the sensory apparatus used to make the observation. In addition, more than one technician was involved and it was necessary for the condition of each of these person's senses to be operating correctly. The point is that there were more places for unreliability due to sensory equipment failure, both human senses and sensing machines, to invade the auto manufacturer's test. However, this source of unreliability was countered by the possibility of seeking coherence from the varied sources of data. A piece of malfunctioning sensory equipment could have been identified if the data it provided did not fit in with that provided by other sources. For example, a large malfunction in the apparatus for sensing the degree of deceleration could be detected by the technician driving the car because the technician probably had a "feel" for whether the instruments were working correctly. Of course small errors would not be noticed in this way.

Unless some specific piece of information was known which cast doubt on the reliability of some piece of sensory equipment, then the principle being considered would not help you, in this case, to judge the more reliable statement.

Reputation for veracity. When a person or group of persons has been known not to tell the truth in certain situations, then we are justified in suspecting further statements made by that person or group of persons. A reputation for not telling the truth should not be identified with a reputation for lying, although lying is one of the things that affects a person's reputation for veracity.

Often, we can point to the cause of a person's continually not telling the truth in certain matters. For example, we might attribute the falsity of the person's statements to that person's lack of knowledge in the field about which the statments are made. If that person makes another statement in that field and we have no reason to think that he or she has increased his or her knowledge of it, then we assume, justifiably that the same lack of knowledge might cause the person to make another false statement.

We learn nothing from the newspaper report about Mr. Wright's reputation for telling the truth. I believe our course of action in this matter should be to give Wright the benefit of the doubt, unless it is extremely important for us to know whether or not he was speaking the truth. If it is important, it would be reasonable to explore Wright's reputation. Otherwise, we should assume that Wright is speaking the truth because it is, I believe, the overwhelming tendency for most human beings to speak the truth in most situations.

The spokeswoman's statement ought to be viewed differently in this regard. Automobile manufacturers have a poor reputation for speaking the truth with regard to the quality of their cars. One of the major factors causing this is their concern with selling as many cars as possible. This is related to the conflict of interest problem discussed previously. Since we have no reason to believe that this auto manufacturer's reputation for veracity is better than that of any other manufacturer, then it is reasonable to suspect the reliabilty of the spokeswoman's statement.

The reputation of automobile manufacturers for telling the truth about their products is so poor that one may wish to make a judgment at this point. One may wish to say immediately that Wright's statement is more reliable. There is a practical reason for doing this. The auto spokeswoman has received negative scores on both conflict of interest and reputation for veracity. These are serious charges. They may be so serious that it is difficult to imagine any combination of positive factors overriding these two negative factors. I believe this is so in the present situation.

At this point, then, I would take Wright's statement to be more reliable and would base my actions upon this position. If I had intended to buy a new Venus, I would, on the basis of Wright's report, not buy one at the present time. I would wait for the Venus brakes to be tested by some reputable and independent group and make my final decision based upon that group's report and reports from other owners of Venuses. The practical advantage of making my decision at this point in the evaluation of the statements is that I save time by not going through all the criteria. If my concern for saving time causes me to make an incorrect judgment I would not have put myself in danger since I chose not to buy a Venus. Hence, saving time may be to my advantage. In other situations, it might

not be reasonable to make a judgment until many more criteria have been examined.

The discussion so far does not present the only way in which decisions regarding the reliability of observation statements are made. Often, the person making a decision will not run through the list of principles one at a time as I did in the auto-brakes example. Rather, the person will notice that one or two criteria are particularly relevant to the case being examined. For example, in the auto-brakes case a person might immediately see the relevance of the conflict-of-interest principle and the reputation-for-veracity principle in judging the reliability of statements in this situation. The person will then make the judgment, seemingly based on consideration of only these two principles, that Wright's statement is more reliable. I used "seemingly based" in the last sentence for a special reason. The reason is this: When basing a judgment upon only those principles for which the relevance is immediately seen, a person skilled in the use of the principles is assuming that if the relevance of a principle is not immediately seen, then it is probably not relevant. In fact, then, all of the principles are taken into account. Some are taken into account explicity; those used to make the judgment. Some are taken into account implicity; those which are assumed to have no bearing. This procedure, when used by skilled people is justified because it usually leads to correct decisions. Whether or not you should use this technique rather than a more systematic appraisal of each principle's relevance depends upon your skill in applying the principles, upon your familiarity with the topic being evaluated, and upon the importance that you make a correct decision. The less skilled and the less familiar you are, and the more important the issue, then the more reason there is for you to use the systematic approach.

So far in this section I have demonstrated how some of the principles dealing with characteristics of the observer can be applied to a particular situation by using them to make a decision about the comparative reliability of two observation statements. I will now discuss each of the remaining principles by explaining their meaning and by showing how they might apply in particular situations. I will begin by discussing those principles which were not discussed in the auto-brakes example concerning the relation of a statement's reliability to characteristics of the observer.

Precise technique. I intend the phrase "using precise techniques" to be taken broadly. Often I will use the phrase to help characterize a person's using some sort of instrument to help make some observations. A person using a thermometer to tell the temperature of some water is using a more precise technique than a person merely using his elbow. At other times I will use the phrase to characterize the care and attention to disturbing factors which a person exercises in making an observation. A person who reads the scale on a thermometer by looking straight at the thermometer is using a more precise technique than a person who reads the thermometer by looking at it obliquely.

In stating the principles concerning the use of precise techniques I use the wording "as precise a technique as is appropriate." I use "as is appropriate" for the following reason. In some situations using a technique which would be more precise does not add to the reliability of the statement based upon the observation. This is so when the technique is more precise than is needed for the statement that is to be made. In the example of testing the temperature of the water, suppose the statement to be made was one of the following: 'The water is too hot for bathing' or 'The water is not too hot for bathing.' In most situations in which water

is tested for the purpose of bathing I do not believe that using a thermometer instead of one's elbow adds to the reliability of the statement about the suitability of the water's temperature. In fact in many situations it would decrease the reliability if, for instance, it was not known at which temperature-in-degrees water is suitable for bathing.

Skill in technique. Being skilled in the observation technique being used is different from being skilled in observing the sort of thing observed. This latter skill has been discussed already. A person who is not skilled in a technique does not know the sources of unreliability in using the technique. Consider the technique involved in using a ruler to measure the length of something. A person not skilled in measuring this way will not know that unreliability of measurement can arise if the rule is distorted near its ends or if the scale does not touch the thing being measured.

Preconceived notions. Under some conditions having preconceived notions of the way observations will turn out tends to decrease the reliability of observation statements based upon those observations. This is so because under some conditions people see what they expect to see even though things are not really the way they are expected. I say "under some conditions" because in situations of which I can think, the mere fact that a person has a preconceived notion does not reduce the reliability of that person's observation statements. It is that person's having the preconceived notion in combination with certain other facts about the person which makes his or her statement less reliable. For example, I would not want to say that usually the reliability of scientists' observation statements which report observations that they had previously predicted is reduced because they had preconceived notions of the way the observa-

tions would turn out. However, if certain other things were true of the scientists, such as their getting additional funding depended upon the observations predicted being made or their lack of experience caused them not to take proper safeguards against making incorrect observations, then their having preconceived notions of the way the observations would turn out would tend to reduce the reliability of their observation statements. In these situations the scientists' conflict of interest or their lack of experience alone would tend to reduce the reliability of their observation statements. The added factor of their having preconceived notions tends to make them make a particular unreliable statement, that is, it tends to make them even less open to alternative observations than they would be without the preconceived notions.

It is also worth noting that persons' having preconceived notions of the ways in which their observations will turn out can lead to their making correct observation statements that otherwise they would not make. A preconceived notion can suggest to a person things for which to look and ways and places in which to observe. As long as that person keeps in mind that he or she must not allow his or her preconception to distort his or her observation, then having the preconception can be beneficial.

In summary, the priniciple covering the effect of preconceived notions on the reliability of observation statements must be applied with extreme caution and informed judgment.

Area II.2: Characteristics of the observation conditions

The two principles contained in this subsection seem almost too obvious to need stating. However, I include them in the list to serve as

reminders of things that need to be checked when assessing the reliability of observation statements.

The first principle states that the reliability of observation statements depends upon the medium of observation. To make reliable statements the conditions of the environment must not impede the sensing process. Foggy or smoky conditions interfere with the sense of seeing; magnets interfere with compasses; background noises interfere with our hearing particular things; the atmosphere interferes with the use of telescopes. To overcome this last source of unreliability of observation statements space scientists plan to mount telescopes on rockets orbiting the earth. In this way they will eliminate the interference from the earth's atmosphere, and thus have a more satisfactory medium for making their observations.

The other principle states that the reliability of observation statements depends upon whether the observer has good access to the phenomenon he or she is observing. So, for example, the claim that a particular painting was done using a certain kind of brush stroke is more reliable if made by a person who can touch and view the painting at close range than a claim made by this person if the painting could be viewed only from a distance.

There are exceptions though. Suppose a person looks at the moon with the naked eye and declares that the moon is in its first quarter. Suppose, instead, that the same person had looked at the moon through a telescope and made the same statement. Although he or she would have had better access to the moon through this instrument, I do not believe this statement tends to be more reliable than the first statement because of this fact. For the claim that was made, looking through a telescope offers no advantage over using the naked eye. However, if the claim was different, about craters on the moon, say, then the observation made using the telescope might tend to be more reliable.

Instruments, such as telescopes, are used to gain access or to gain better access to phenomena that would without the instruments be inaccessable to observation or only poorly accessable. Because instruments are used to increase the accessability of phenomena to observation, principles governing the reliability of statements based upon their use are included under the more general principle about the accessability of phenomena. A discussion follows of the reliability of observation statements made using instruments.

I will use 'instrument' to refer to a wide variety of devices which are used either to increase the accuracy of an observation or to make an observation possible. Such things as rulers, thermometers, bathroom scales, speedometers, achievement tests, ammeters, clocks, electron microscopes, and smoke detectors are instruments in the sense I am using the term.

In order to discuss some principles which are helpful in judging the reliability of observation statements made with the help of instruments imagine the following situation. You plan to buy a piece of plate glass to protect the surface of an antique wooden table you just purchased. The table is constructed to hold such a piece of glass. On each side of the table there is a moulding which extends about one-quarter inch above the surface of the table. The piece of glass is supposed to fit snugly in the frame thus made. You begin to make the measurements before placing your order.

Suitably precise instrument. When I say that an instrument is more precise than another I shall mean that the more precise instrument is constructed so that the measurer can confidently make a finer discrimination between values than can confidently be made using the less precise instrument. For example, an IQ test which can dependably detect

differences in IQ as small as 5 points is more precise than an IQ test which can dependably detect differences in IQ only if those differences are greater than 10 points.

If the same observation statement is made using two instruments, one more precise than the other, then following this principle a person would judge the statement more reliable when made using the more precise instrument. This is so because the closer an instrument is pushed to the limit of its capability, the less dependable measurements are. If used to make the same statement, the less precise instrument is pushed closer to the limit of its capability than the more precise instrument.

Not all observation statements based upon more precise instruments are more reliable than those based upon less precise instruments. A temperature reading of 36.45° based upon an instrument designed to measure to two decimal places might be just as reliable as a temperature reading of 36.452° based upon an instrument designed to measure to three decimal places. If the instruments are of equal quality and used by equally skilled measurers, then the reliability of the statements is likely to be equal. This is so because although the statement based upon the more precise instrument gives a more accurate measurement and thus tends to be more reliable, it also makes a stronger claim about what the measurer knows and is thus harder to defend, tending to make it less reliable. Having no way to judge the relative size of these counteracting factors it is best to assume their combined effect is zero.

Suppose in your case you do not want the glass for your antique table to be more than one-sixteenth inch shorter or narrower than the frame. Therefore, you need a measuring instrument that will allow you to distinguish measurements as small as one-sixteenth inch. If you choose

such an instrument your measurement will be more reliable than if you had chosen an instrument of lesser precision, given that the measurement you make is expressed in dimensions of one-sixteenth inch.

Range of application. An instrument is used beyond its range of application if it is used to make an observation for which it is not suitable. For example, second hands on wrist watches are not suitable for making observations of time differences of less than a second or so. Observation statements of time differences of the order of one-half second made using a wrist watch tend to be unreliable. Measuring sticks and tapes used to measure length tend to give more reliable measurements when the thing being measured is shorter than the stick or tape than when the thing is longer. If you used a one foot ruler to measure your antique table and that table was three feet long, unreliability would enter your measurement each time you had to mark the position of the end of the ruler and move the beginning of the ruler to that position. You could avoid this source of unreliability by using an instrument whose range of application is more suitable to your task. A ten foot steel tape, say, would be more suitable.

Good quality instrument. Instruments come in various qualities. The quality of instruments affects the accuracy and hence the reliability of statements based upon their use. Thermometers in which the tube carrying the liquid varies in diameter tend to be less accurate than thermometers in which the diameter varies by smaller amounts. Compasses in which the needles sometimes stick on the glass tend to be less reliable indicators of direction than compasses in which this does not happen.

The quality of the tape measure you use in measuring your antique table affects the reliability of the measurements you give. If the markings

on that tape are not evenly spaced, your measurement will tend to be less reliable than if you had used a tape on which the lines were evenly spaced. If the tape you use is not straight, your measurements will tend to be less reliable than if you had used a straight tape.

Instrument's workings are understood. If no one can give good reason for saying that an instrument measures a particular thing, then that instrument tends to be a more undependable measure of that thing than an instrument that is well understood. The explanations of why instruments work vary in kind and in quality. Generally speaking, more complicated instruments require more elaborate explanations of their workings than is required by less complicated ones, if the instruments are to yield equally reliable measurements.

The body of knowledge explaining how an instrument works is often the body of knowledge that was used to design the instrument in the first place. This is not always the case. The first telescope was constructed before anyone knew how telescopes worked. When an instrument is designed according to a more corroborated body of knowledge than another instrument, we can depend upon that first instrument more than the other to measure what it is claimed to measure. The instrument that is based upon the more corroborated body of knowledge is more likely to be doing what it is claimed to do. This is so because the more corroborated body of knowledge has been subjected to more tests and has passed more tests than the less corroborated one. Loosely, this means that more ways in which the body of knowledge could have gone wrong have been eliminated, and more ways in which the instrument might have been constructed incorrectly are eliminated.

In your case of measuring the dimensions of a table, the workings of the instrument you will use are well understood.

Good working condition. That instruments need to be in good working condition in order to give reliable results is, I believe, unlikely to be disputed. Stating the principle is, however, worthwhile. It is a reminder of a factor which might adversely affect the reliability of observation statements and thus of a caution to keep in mind when trying to make observations. The working condition of an instrument can be affected by many things. For example, the working condition of the ruler you might use to measure your table could be affected by its degree of straightness, the clarity of its scale, and the amount of wear near its end.

Area II.3: Characteristics of the observation statement

The reliability of observation statements varies with certain characteristics of the statements themselves. Some of the principles in this section are not as apparently true as those in the last section. I will thus devote more time in this section than in the last to explaining and defending each principle.

Committment of speaker. This principle states that an observation statement tends to be more reliable than another when it commits the speaker to holding fewer things true than that other statement. The principle is intended for use in cases like the following one. This is a case that has been discussed previously. Consider a speaker making one or the other of the following two statements having observed the reading on the thermometer: "The temperature in the room is 70°"; "The top of the liquid in the thermometer is at the number 70." In the context I am

imagining the speaker is committed to holding more things true when asserting the first statement than when asserting the second. The first statement commits the speaker to holding true all that the second statement commits him or her to holding and in addition commits the speaker to holding other things true. The first statement commits the speaker to holding that the room has a particular temperature. The second statement does not commit the speaker to this.

Corroborated. When statements become more corroborated they also become more reliable. To become more corroborated they have to withstand more situations in which their truth is put to the test. A principle of diminishing returns applies here though. The more a statement is put to the test, the less its reliability increases with the passing of each test. For example, the amount by which the reliability of the statement "There was a loud boom in our city last night" increases is less when the one hundredth person claims to have heard it than when the tenth person claimed to have heard it. However, the discovery of a new type of evidence would increase the reliability by a larger increment than the addition of more evidence of the same type. If it was discovered after the one hundredth person had confirmed hearing the loud boom, that, unknown to anyone, a truck carrying explosives had exploded just outside town, this discovery would confer a larger amount of reliability on the statement that there was a loud boom than another person's claim to have heard the noise.

Observation statements can become more corroborated in other ways than being put directly to the test. Consider the statement that the Atlantic Ocean is gradually becoming wider. This statement reports an

observation made using very sensitive instruments. It forms part of the evidence for the theory that the continents were once joined together but are slowly drifting apart. Suppose the theory received independent support from another source. Suppose, for instance, that a type of rock formation is discovered on the east coast of South America and on the west coast of Africa. The formation is unknown in other parts of the world. The new discovery lends additional support to the theory that these two continents were once joined together and have since drifted apart. However, since the theory of the drifting continents is now more corroborated, the observation statement that the Atlantic is widening is also more corroborated and thus more reliable because we have an additional reason for believing the statement. The reason is that the statement tells what one would expect to find given the theory is true and there is now more reason to believe the theory is true.

Justified precision. The precision that can be justified in an observation statement is dependent partly upon the technique used. Using a good quality wooden meter stick a trained scientist would be justified in giving lengths to two decimal places. Using a vernier caliper he might be able to give readings to three places, depending upon the quality of the particular instrument being used. A pilot flying over the site of a county fair would probably be justified, depending upon his experience in such matters, in saying that there were between two thousand and three thousand people at the fair. However, a pilot would be unjustified, in most situations I can imagine, in saying that there were two thousand three hundred fifty-one people. The technique of observing crowds of people from the air just does not allow one to be that precise. When the precision claimed in the observation statement is greater than that which could

be reasonably expected from the technique being used, the reliability of the statement is reduced.

Close to time of observation. Many things can happen to interfere with the accuracy of an observation statement between the time an observation is made and the time the statement is given. Some interferences arise because many people have bad memories and because often people confuse things with other things they have observed. One way to help minimize the errors which occur from these sources is to make the observation statement as soon as possible after the observation is made. The purpose of this principle is to urge that statements which have been made with this precaution tend to be more reliable than those which have not been so made.

Person who made the observation. This principle states that an observation statement tends to be more reliable when it is made by the person who made the observation. The principle is based on the following widely accepted statements. When information is passed from one person to another there is a chance that something will hinder the second person giving an accurate report of what the first person said. Accuracy of the second person's report would be hindered if that person places an interpretation on what was said that is different from the one the first person intended. The second person's memory is also a source of hindrance to his or her statement's accuracy. As the chain of people grows, the number of sources of error increases. Hence, the statements given by people removed from the original observations tend to be less reliable than the statement made by the person making the observation.

These last two principles do not rule out the possibility of making reliable observation statements using informaton from other people or

making reliable observation statements a long time after observations have occurred. In many situations people do things to counteract the unreliability introduced by such factors. One way to do this is to make a record of the observation at the time the observation is made. Using such a record I can thus make a reliable observation statement stating that the maximum temperature on November 8, 1978 was 8°C in Toronto, Canada. However, if we use records we need principles to judge the reliability of statements made using them. The discussion of such principles will be the focus of a subsequent section.

Belief the statement is corroboratable. This principle states that if an observer believes his or her observation statement can be checked by other people, then it tends to be more reliable than if the observer did not believe this or if he or she believed the statement could not be checked. The following example illustrates the principle. Suppose you bring your watch to a repair shop and complain that you have seen the date indicator skip a day on several occasions. The jeweler examines your watch and finds nothing wrong. Despite this the jeweler might judge your complaint as reliable. You were willing to submit your statement for independent corroboration. If you did not believe that your statement was correct you would not likely have gone to the repair shop. It is embarrassing to be shown wrong by other people and we try to avoid placing ourselves in embarrassing situations. This tendency to try to avoid being shown wrong tends to make your statement to the jeweler more reliable.

As with the other principles, in some cases the final decision on the reliability of a statement will be in the direction urged by this principle. In other situations the direction of the final decision will be opposite to that urged by the principle. Suppose a school-aged child announces to

his parents on the morning that his class is to have a mathematics quiz that he has a bad stomach ache. Suppose, in addition that the parents knew that their child had not studied for the test as much as he should have. It is reasonable to assume the child believes that his observation statement reporting his stomach ache is not easily checkable by other people. This tends to make the child's statement unreliable. In addition, it would be advantageous to the child if his parents accepted his statement (they would keep him home from school). For these reasons his parents would probably judge his statement unreliable. In this situation the principle concerning independent checkability points one in the same direction, towards unreliability, as the direction of the final decision.

Suppose, however, that another child claimed to have a stomach ache on a day she was to go camping. Suppose she was looking forward to this camping trip very much. As in the previous case the fact that her statement is not checkable by other people tends to make it less reliable than a statement that is so checkable. However, since it would be to her disadvantage for her parents to act upon her statement, the child's statement should probably be judged reliable. In this situation the principle concerning independent checkability points one in a direction opposite to that of the final conclusion.

Fits into a body of knowledge. The reliability of an observation statement is enhanced when it describes something expected in the light of a larger body of knowledge, and diminished when it describes something not expected in light of a body of knowledge. Here is an example. An abnormally high air pressure reading in the tires of your car is reliable if the tires were set to the normal pressure when the temperature was much colder and if the sun has been shining on the tires for several hours. The body of knowledge conferring this reliability includes our

experiences showing that pressure increases with temperature and the theoretical explanation in physics explaining why pressure increases with temperature. Reliability is conferred to the obervation of the abnormally high pressure by the larger body of knowledge because the body of knowledge is itself reliable, and because one would expect an abnormally high pressure in light of this body of knowledge. An observation of a normal air pressure in the situation described would be unreliable because it would conflict with something in which we have very good reasons to believe.

Here is another example illustrating this principle. When driving on the highway on a sunny day an observation that there is water on the road ahead is made unreliable by the wealth of experience indicating that many such observations in similar situations have proven to be wrong. It is also made unreliable by the fact that science can explain why the road appears wet under these conditions when, in fact, it is not wet.

As with all the principles, caution must be exercised when applying this principle. There are cases in which observation statements can be instrumental in the overthrow of bodies of knowledge, even though following this principle would lead one to judge the statements unreliable in light of those bodies of knowledge. For example, it was once believed that bodies while burning give off a substance called "phlogiston". Also, it was observed at that time that some substances increase their weight when burned. Accepting the belief in phlogiston, observations of materials increasing their weight when burned were justifiably judged unreliable. However, accepting other bodies of knowledge concerning the weighing of materials which existed at the same time the phlogiston theory was held, the observations of increased weight were justifiably judged reliable. The

strong belief by some scientists of the phlogiston era that the observations of increased weight were reliable led them to the development of another theory of combustion. This new theory, which did not postulate the existence of the substance phlogiston, predicted an increase in weight of some burned objects. It is essentially the theory we hold true today. Hence, an observation statement like "This material's weight increased when it was burned", which is justifiably judged unreliable in light of the phlogiston theory, was instrumental in the overthrow of that theory.

Based upon a record. There are occasions when people want to make reports of observations that were made sometime in the distant past. On such occasions people often appeal to their memories to recall what happened. However, experience has shown that memory is very unreliable. To help alleviate this unreliability in reporting on past observations, records of observations are often made. When a person uses a record to report an observation, I will say that person's report is an observation statement. For example, if a person using information gathered in a newspaper reports that the sun rose at 6:03 a.m., I will call this report an observation statement. I will consider the fact that the person making the statement is not the one who made the observation unimportant in identifying the statement as an observation statement. What I will consider important is the fact that the statement does report what someone observed.

Observation statements based on records in this manner can have various degrees of reliability. The degree of reliability such observation statements have is partly dependent upon the quality of the records. I will illustrate with an example some principles for judging the reliability of observation statements taken from records.

Suppose you are a patient in a hospital. Your doctor visits you, reads your medical chart and reports to you that your blood pressure reading is 120/80. The blood pressure reading upon which the doctor bases this claim was made by a nurse a while ago and was recorded by that nurse on your chart. The doctor judges the observation statement she made reliable. At least you assume this from the confident manner in which she stated it and from the fact that she bases action upon the statement (she reduces your medication). On what grounds might you judge whether her statement is reliable?

Records of observations tend to be more reliable when they are made at the time of the observations. Nurses are trained to record their observations as soon as possible after they are made. This practice reduces the chance that what is recorded will be distorted by things such as poor memory or the confusion of one patient's statistics with those of another patient. Most nurses do as they are trained. Because nurses usually make their records at the time of their observations, the record of your blood pressure tends to be a more reliable indication of the pressure your nurse observed than if, say, nurses usually made all their records at the end of their workday.

The reliability of records of observations tends to be decreased if they are made by persons different from those who made the observations. This is so because the transmission of the information from the observer to the recorder adds another source of error that is not present when the observer makes the record. You probably know whether the nurse who observed your blood pressure also recorded the pressure reading on your chart. If the observer and recorder were the same person, the record tends to be more reliable than if they were different people.

If the person or group making a record has a reputation for making correct records, then this fact enhances the reliability of observation statements based upon that record. This is so because the making of correct records on a number of occasions is evidence that the group will make correct records on other occasions. Nurses, in general, have a reputation for making correct records in situations where their job requires them to make records. Your doctor will probably have information on the reputation of the particular nurse who made records of your medical statistics. If that nurse has a reputation for making correct records, this information would tend to increase the reliability of the doctor's statement. If this particular nurse has a reputation for making incorrect records, then the records are not dependable sources upon which to base observation statements.

If the person making an observation statement from a record believes that the record is correct, then under some conditions that person's belief tends to make the statement more reliable. This principle is difficult to grasp, and may be difficult to accept as I have just stated it. I will attempt to justify the principle.

When people claim to believe the records upon which they base their statements, then they often have some reason to support their beliefs. For example, your nurse might now believe that the records your doctor is using are correct because he remembers believing that they were correct at the time they were made. If your nurse usually bases his belief upon sound reasons, then he can assume that at the time the records were made he based his belief in their correctness upon sound reasons. This justifies his believing the records at this time even though he may not remember his initial reasons for believing the records. This in turn gives us a reason to believe the records.

In another situation a person may believe that a record is correct because he or she believes that the person who made the record usually makes correct records. Such a belief, for most people, would be based upon some experience with the record-maker's ability to make records.

A main point of the two cases I just described is to point out that, in discussing this principle, when I say "belief" I mean justified belief not mere belief.

If your doctor tries to assure you of the correctness of your records by saying that she believes the records are correct, you should place some confidence in this statement. You ought not, unless you have a special reason, take the doctor's statement as trivial, as a statement of mere belief. Rather, you should assume the doctor bases her belief upon some sound reasons, and that these reasons make a statement based upon the records more reliable than if reasons could not be given.

The final decision about the reliability of your doctor's statement needs to be based on principles other than those relating to records. The observer must be taken into account, as well as the observation conditions, the nature of the statement made, and the instrument or instruments used to help make the observation. The medical profession has specified a manner for making and recording observations which enhances the reliability of observations of patients as much as is reasonable to expect. The observers are trained well, are usually alert, use precise techniques, etc. The conditions are also favourable for making reliable observations. Rooms are usually well lighted, there is usually a minimal amount of disturbance, etc. Instruments are usually of high quality, have been extensively tested, are used by people skilled in their use, etc. Upon these facts, as well as upon the considerations offered in judging records, you

ought to judge that the doctor's statement of your blood pressure is reliable.

I am not suggesting that you ought to go through such thought processes to judge the observation statements doctors make in their work. In fact, the usual practice is to assume their statements are reliable unless something is noticed which appears to cast doubt upon their reliability. In many situations it would be innappropriate to attempt methodically to apply, one by one the principles offered here to judge the reliability of a statement. A more reasonable approach in the blood pressure example would be to take the statement as reliable unless something stood out which indicated that the reliability was in doubt. One value of the principles is that for people versed in them reliability-reducing factors "stand out" more quickly and more obviously than for those not versed in them. Thus a person knowledgeable of the principles is likely to identify an unreliable statement before a person who is not familiar with them. Another value of the principles is that they can serve as guides for making judgments of reliability in difficult or unfamiliar situations where the judgment which should be made is not obvious. Still another value is that they can serve as guides to practice in formulating procedures to enhance reliability in situations where many reliable observation statements must be made. A final value is that the principles can serve as a pedagogic device to introduce students in a systematic manner to a complex set of problems and procedures for dealing with these problems.

SUMMARY

In this paper I have offered a conception of observation statements which distinguishes those statements as those which tend to be the most reliable statements of our knowledge of the world. I have also presented,

defended, and illustrated the application of a set of principles for judging the reliability of observation statements. The principles deal with influences on reliability which come from three different sources: the observer, the observation conditions, and the observation statement. I have urged throughout the paper that the principles must be applied with judgment and flexibility.

While many of the principles may seem to be truisms, having the list explicitly presented is advantageous in several ways. In the first place, for a person who is well versed in the principles and their application factors which reduce the reliability of observation statements in particular cases will tend to stand out. Also, such a person might be able to express his or her reasons for thinking a statement is unreliable in a situation where that person would not have been able to do so had he or she not been familiar with the principles in their explicit form.

Second, in unfamiliar situations it is not as likely that factors affecting the reliability of observation statements will be as readily apparent as they would be in more familiar situations. The list of principles can serve as a guide in such situations for making judgments of reliability. The principles can be used to suggest the questions that should be asked in evaluating reliability.

Third, the list of principles can serve as guides to practice in devising procedures to enhance reliability. If one is in a situation where many reliable observations must be made, the principles can indicate the sources of unreliability which must be taken into account. The principles can point to places where safeguards must be built into the observation procedures.

Finally, the list of principles can be useful pedagogically. The list can be used as a curriculum outline for a course designed to teach students about factors which affect the reliability of observation statements. Or, the list can be used to suggest places where discussions of reliability of observation statements might fit easily and appropriately into existing courses, such as science or history. In addition, the list can serve as the basis for tests which evaluate students' ability to detect factors affecting the reliability of observation statements and their ability to judge the influence of these factors on the reliability. Whereas many tests of thinking abilities are built upon undefined notions of what is being tested, these principles provide a reasonably detailed list which could be the basis for the construct validity of a test.

Knowing how to judge the reliability of observation statements is an important critical thinking skill. Maybe this list of principles and its explanation and defence will be helpful in fostering these important skills in our students.

NOTES

1. I wrote this paper assuming that people from many fields might read it. One reason for writing the paper is to provide the theoretical support for a test designed to assess peoples' ability to judge the reliability of observation statements. Since science educators, school board supervisors, teachers, testing experts, and philosophers, among others, would probably be interested in a test of this sort, this paper will probably reach a diverse audience. It is likely that each reader will find some things in this paper trivial and other things very complex, since I was attempting to satisfy so many groups. I apologize to my readers for this and ask them to try to bear with my work.

2. Despite the influence that eyewitness testimony can have in a trial, Wigmore (1935) has emphasized that there is no rule requiring eyewitness proof (p. 309), nor is there any rule which says that such proof has a special preference (p. 231). To further support this latter point, Wigmore cites several cases in which circumstantial evidence was used to overthrow the testimony of eyewitnesses (Sec. 20). But, as Wigmore attests, testimony of eyewitnesses is an important source of evidence.

3. Many science textbooks, for example the BSCS biology text (1963), stress the importance of observation in science. The BSCS book tells students that: "In his own special field of work, each scientist bases his beliefs on his own careful observations, checked and confirmed by the observations of others. Skill in observing is, then, a basic requirement of science." (p. 5) Although this passage might lead students to the misconception that a scientist has his own observational support for everything that he believes, it does correctly point out the importance and function of observation in science.

4. My thinking in this area has been influenced to a great deal by the following work: Quine (1960, esp. p. 42-45), Quine (1969, esp. p. 84-90), Quine and Ullian (1970, Ch. 2), Quine and Ullian (1978, Ch. 3), and Ennis (1969, esp. p. 384-388). Quine and Ullian have modified their doctrine in the second edition of their book. The view I present is more in line with their first edition doctrine. In that first doctrine they allowed the distinguishing of observation statements from other statements to be done relative to the field of knowledge and community of speakers within which the statements were made. Thus a statement might be an observation statement for one group of speakers and not for another. In their second edition they do not allow this relativism.

5. I believe our ability to recognize observation statements is superior to our ability to point to the features of those statements which we use to recognize them as such. Thus, in my attempt to distinguish features of observation statements, I first identified on the basis of my intuitive judgment statements which I considered to be observation statements. I then examined these statements for features which could be used to distinguish them from other types of statements.

6. I believe the characteristics which I identify are characteristics which any statement must have to be an observation statement. However, I do not believe that a statement's having any one or any combination of the characteristics is a sufficient condition for saying that that statement is an observation statement.

7. There is a view in philosophy which holds that observation statements can be distinguished from other statements by merely looking at the sentences (that is, the actual words) used to make those statements. The view depends upon assuming that the non-logical vocabulary of language can be divided into two parts: observation terms and theoretical terms. (The logical vocabulary includes the following words among others: 'if', 'and', 'or', 'but', 'only'.) Observation statements on this view are those statements containing only observation terms and logical words. Theoretical statements are statements containing theoretical terms. This view has been shown incorrect, I believe, by Putnam (1962) and by Achinstein (1965 and 1968). Their arguments rest partly on showing that observational terms can be distinguished from theoretical terms only by considering the context in which the terms were used. When one considers context, then it can be shown that the same words can be theoretical in some contexts and observational in others.

   I hold a similar view to that of Putnam and Achinstein. I also believe that observation statements can be identified as such only after taking into account features of the situation in which the statements were made. I do not believe that an observation statement can be identified as such merely by looking at the words that were used to make it. However, the words themselves can or cannot make one suspect that a statement made using them is an observation statement. Certain forms of words are more likely candidates than others to have been used to make an observation statement. Characteristic B picks out one such form of words.

8. Robert Monk (1978) has argued, convincingly I find, that scientific observation need not involve the use of human senses at all. Some observations could be made, Monk claims, completely by machine, once they are set up and turned on. Even the observation statement itself, the report of the observation, could be made by the machine. That is, the machine could be programmed to control a typewriter or other printing or recording device.

9. There has been a long history of foundationalism in philosophy. Foundationalism is a view which holds that our knowledge is made up of statements which form sort of a structure with some of the statements relying upon some of the others for their support. The analogy with the structure of a building is appropriate. The structure of our knowledge might consist of various "levels" of statements, as a building might consist of various levels. Those supporting different views of foundationalism maintain that our knowledge is composed of different numbers of levels. There is much disagreement on this point. There is agreement among foundationalists that some statements in the structure must not rest on other statements. Those statements are the foundations. They must get their support from sources other than other statements or else they must be self-supporting. For various classical works on foundationalism one might

see the following, all of which are technical: Austin (1964), Ayer (1952, esp. p. 5-26), Lewis (1946, esp. Ch. 8 & 9), and Chisholm and Swartz (1973, esp. Ch. 5).

The view I present in this paper is foundationalist in that I believe that observation statements are used as the basic support of many inferences based upon them. However, I depart from many of the foundationalists in that I do not believe that observation statements are infallible nor do I believe that the lines of support always go from the observation statements to the inferences based upon them. I believe that inferences can be used both to support and to overthrow observation statements, although this is not the usual state of affairs. However, in times when all the theoretical (inferential) knowledge we have good reason to believe leads us to think that a reported observation ought not to have been observed, then such an observation statement becomes suspect and is sometimes rejected on the basis of the theoretical knowledge.

10. The statement of this characteristic may seem circular to some because of the restrictive clause "who have made the same observation". It may seem circular because characteristic E is intended to be helpful to people in picking out observation statements, but to be able to use the characteristic one must first decide that people have made the same observation. But one of the best ways to decide whether people have made the same observation is to examine the observation statements they make to see if the statements are the same. To do this, one has first to identify which of the peoples' statements are observation statements. But this latter task is one for which the characteristic was designed. Hence, the circle.

The statement of characteristic E would not be circular if one could decide that people have made the same observation without examining the observation statements they make. I believe that this can be done. One can decide that people have made the same observation even if those people do not make any report of their observation in a statement. Other evidence that people have made the same observation can be gained. For example, if two people are facing the same direction, and both cover their eyes when a blinding light flashes in front of them, one could justifiably conclude that those two people have made the same observation. That is, evidence from the situation, other than what the observers report, can be used to decide whether the people have made the same observation. In the above example, the evidence from the situation was the following two things: both people were facing in the same direction, and both covered their eyes after the blinding light flashed.

11. I say "in most cases" because there are situations in which a statement can be more reliable than the statements upon which it is based. I consider an example of this, the voting example, near the beginning of the next section. However, I will give another example here. Suppose a person counted the number of growth rings in the cross sections of two trees. Suppose, having finished the counting, the person made the following three statements, basing the third on the first two: "Tree A has 45 growth rings"; "Tree B has 150 growth rings"; "Tree B is older than tree A". I believe that the third statement is more reliable than the first two statements, even though

it is based upon them. I believe this because I know it is very easy for a person to miscount, by a small number, the growth rings on a tree, but that it is very unlikely that a person's miscounting could account for the large difference reported in the first two statements. Hence, while it is likely that the first two statements are in error by a small amount, it is unlikely that they are in error by as much as the difference between the two counts. So, even if the first two statements were found incorrect and corrected, the statement based upon the revised statements would likely be the same as the third statement is now. Hence, the third statement is more reliable than the first two.

12. The list of principles I give are based upon the list given by Ennis (1962) and conversations with him and other members of the Illinois Rational Thinking Project. The main differences between Ennis' list and my list are: (i) I have included principles applying explicitly to observations made using instruments; (ii) I have added some principles dealing with the nature of the observation statement; and (iii) I have made changes and additions in the list of principles dealing with records of observations.

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